TORREYA

January, 1910

Vol. 10 No. 1

THE VEGETATION OF THE NAVESINK HIGHLANDS *

By John W. Harshberger

The Highlands of Navesink, or, as they are sometimes called, the Atlantic Highlands, occur in the northeastern part of coastal New Jersey and are found as a projecting peninsula between Sandy Hook Bay on the north and Navesink River on the south. The deposits which constitute the highlands are mostly of Cretaceous age and some of the strata are fossil bearing. The strata consist of quartz sand, green sand, marls, and ferruginous red sand, the latter nearly one hundred feet in thickness. Some of the more typic layers belong to the Marl Series (Navesink Marl) of the New Jersey geologists. This series of deposits is, on the whole, more resistant than the beds below, and has been less deeply eroded. One result of its greater resistance to erosion is that its northern edge is marked by a steep, often scarp-like face (Fig. 1). The lowermost division of the marl series, the Lower Marl, is more easily eroded than the Red Sand immediately above it, both being represented in the Navesink Highlands. The red sand is the most important factor in forming the obtrusive range of high hills extending southwest from the Navesink Highlands.†

The front of the bluff is protected from the full force of the ocean waves by the projecting sand peninsula, which terminates

* Illustrated with the aid of the Catherine McManes fund.

† The difficult interpretation of the stratigraphy of the Cretaceous formations in New Jersey will be found in Annual Report of the State Geologist for 1886 : 154–184 ; Salisbury, Rollin D. : The Physical Geography of New Jersey 1898: 115–128 ; Weller, Stuart : A Report on the Cretaceous Paleontology of New Jersey, Geol. Surv. of N. J., Paleontologic Series IV : 11–26 ; Geologic Atlas of the United States, Philadelphia Folio No. 162, also Trenton Folio No. 167.

[No. 12, Vol. 9, of Torreya, comprising pages 241–284, was issued December 31, 1909.]

in Sandy Hook; and the Navesink River joined by the Shrewsbury River enters Sandy Hook Bay by flowing past the projecting bluff. However, on consulting the map* of 1737 and the one drawn from the surveys made in 1769 (by order of the commis-

FIG. 1. Map of the Navesink Highlands, New Jersey

sioners appointed to settle the partition line between the provinces of New York and New Jersey) by Bernard Ratzer, lieutenant in the Sixtieth regiment and in 1777 of the northern parts by Gerard

*See the map of 1737 in article by G. R. Putnam entitled Hidden Perils of the Deep. National Geographic Magazine, XX, p. 825, Sept., 1909. The later map was engraved and published by Wm. Faden, Charing Cross, December 1, 1777, and a facsimile published by the N. J. Geol. Survey in 1877.

Banker, it will be found that at those dates the cliff was open to the full force of the ocean and that Sandy Hook was attached as a projecting spit of sand to the highland shore. Since that time, according to Lewis M. Haupt,* the drift from the bluffs to the southward (as at Monmouth) has gradually overlapped the foot of the Highlands and closed the mouth of the Shrewsbury and Navesink rivers,† thus serving as an effectual cover and protection for the highlands, which are no longer attacked by the ocean waves, while Plum Island (Fig. 1) represents a remnant of the ancient Sandy Hook. The undisturbed, forest-covered portion of the Navesink peninsula (the highland proper) is three and a quarter miles long and one and a half miles wide, the highest elevations (triangulation points) beginning at the west end being 239 feet, 245 feet, 260 feet, 269 feet, 235 feet, and 248 feet; while the elevations at the eastern end (see map, Fig. 1) toward the Atlantic are 240 feet and 259 feet; the hill on which the Navesink lighthouses are situated being 237 feet high. On the north and east sides, the bluffs are rather precipitous, as indicated by the closeness of the contour intervals, while on the south and more protected sides, the slope is a more gradual one. The differences in these slopes is probably accounted for by the action of the ocean and tidal currents in wearing away the material, so as to undermine the bluff and produce steep contours. From a distance, the crest of the Atlantic Highlands (Fig. 2) seems to be a fairly uniform one and a closer inspection shows that there are no streams of any importance which cut its slopes. The largest brook runs south into Clay Pit Creek flowing in a northwest direction which marks a valley which separates the highlands proper from the hills to the westward.

Vegetation

The forest, found on the summit and slopes of these highlands, belongs to what I have denominated the deciduous forest forma-

* *Haupt, Lewis M.* Changes along the New Jersey Coast. Annual Report of the State Geologist, 1905 : 44–45.

† *Harshberger, John W.* The Vegetation of the Salt Marshes, Salt and Freshwater Ponds of northern Coastal N. J. Proc. Acad. Nat. Sci. Phila., 1909 : 373–400, with 6 text figures.

tion. This is the type of forest which covers the valleys, hills, and lower mountain slopes of northern New Jersey. It is not a typic mesophytic forest, such as we find in the valleys and on the hills with rich, moist soil fed by numerous springs and drained by actively flowing creeks and rivers. The soil is a stiff one, and rather dry than otherwise, for the absence of springs and rapid streams indicates rather dry conditions. Besides the forest

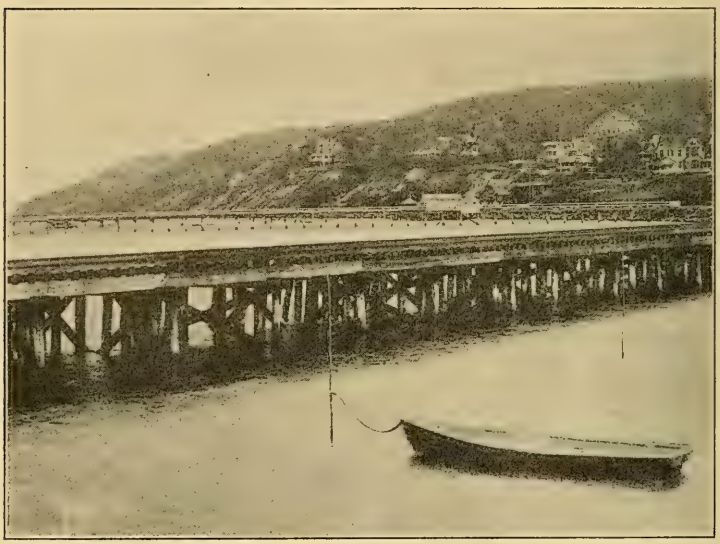

FIG. 2. Navesink Highlands looking southeast from steamship pier at Atlantic Highlands.

is exposed to the full force of winds which blow from the north, east, and southeast and is more or less exposed to south winds which blow across the half-mile-wide Navesink River. A reference to a portion of the map represented in figure 1 will show the relative shape of the peninsula and its exposure to the cardinal points. The original forest is being rapidly encroached upon by the growth of such towns as Highlands, Water Witch Park, and Atlantic Highlands (Fig. 2), while as summer camping sites should be mentioned Shady Side, Hilton Park, and the shore along Sandy Hook Bay.

Deciduous Forest Formation

The forest consists of dominant forest trees whose crown is close enough to shade the secondary layers beneath. If one consults the forest map issued by the Geological Survey of New Jersey in 1900, it will be seen that on the Navesink Highlands there are 80 to 100 acres of forest to 100 acres of upland. The trees which form the facies are most of them mature and already show evidences of decay. The facies varies somewhat on different portions of the bluff, but in the main, it consists of *Castanea dentata* (Marsh) Borkh., *Quercus prinus* L., *Q. velutina* Lam., *Q. alba* L., *Q. coccinea* Wang, *Q. rubra* L., mentioned in the order of their relative abundance, so that it may be called the chestnut-oak facies. Mixed with these trees and reaching a size equal to the dominant trees occurs *Hicoria* (*Carya*) *glabra* (Mill) Britt., while of rare occurrence are *Fagus americana* Sweet, and *Liriodendron Tulipifera* L. The almost entire absence of these two trees seems to indicate that the climax forest of *Castanea dentata* and *Quercus prinus*, etc. has not reached the most typic mesophytic conditions where the beech and the tulip poplar are among the most important elements of the facies. Other trees, occasionally found, are *Pinus rigida* Mill, *Betula populifolia* Marsh, *B. lenta* L., *Populus tremuloides* Michx., and *Liquidambar Styraciflua* L.

The prominence of the black oak, *Quercus velutina*, in the chestnut-oak facies suggests an association described by Jennings * on Presque Isle in Lake Erie, where the black oak constitutes usually 85 to 95 per cent. of the primary layer of the forest. At Cedar Point, Sandusky, Ohio, the peninsula is an almost exact counterpart of the *Quercus velutina* habitat on Presque Isle. In the North Haven sand plains of Connecticut the black oak, although scattering, is yet the dominant tree, and at Ypsilanti, Michigan, the arid slopes of a sandy bluff are characterized as a black oak society by Brown. Cowles finds near Chicago *Quercus velutina* predominating on the south slopes of the established sand dunes and on the higher sandy ridges and beaches of glacial origin. From this and other evi-

* *Jennings, Otto E.* A Botanical Survey of Presque Isle, Erie County, Pennsylvania. Annals of the Carnegie Museum V : 325.

dence it would seem that the black oak shows a pronounced xerophytic habit under certain edaphic conditions, and with its associates previously mentioned is adapted to the rather stiff, dry, surface soil of the Navesink Highlands.

The secondary layer of the forest is composed of small trees of the dominant species together with smaller trees and shrubs which never lift their crowns to the same level as the taller trees, but are always found growing beneath them. Such are in the order of their greatest abundance *Cornus florida* L., *Acer rubrum* L., *Prunus serotina* Ehrh., *Sassafras Sassafras* (L.) Karst., *Quercus marylandica* Muench., *Q. prinoides* Willd., *Q. nana* (Marsh) Sarg. (the three latter common in the dry pine barrens of the state), *Amelanchier canadensis* (L.) Medic., and occasionally *Juniperus virginiana* L. In some places, notably in the western part of the region noted in this reconnaissance, the smaller trees are reduced to a few specimens ; in other places they become more abundant, especially in the center of the highland forest where the original conditions have been preserved. Where the growth of the dominant species is an open one, the third layer of shrubs may be wanting, as well as the associated lianes, but such an open forest probably indicates that the original growth has been disturbed by man. The vines, or lianes, which are supported in their growth toward the light by the smaller and larger trees comprise, according to my notes made in 1908 and 1909, the following : *Parthenocissus quinquefolia* (L.) Planch., *Smilax rotundifolia* L., *Rhus radicans* L., and *Vitis labrusca* L., with *Celastrus scandens* L. in the denser woods with more humus and soil moisture.

The composition of the third layer, or that of the shrubby growth, is quite dependent upon the edaphic conditions of the soil. In the dry soil, we find the constituent elements of this layer composed of shrubs which occur in dry woods throughout northern New Jersey, such as *Kalmia latifolia* L., *Gaylussacia frondosa* (L.) T. & G., *Myrica carolinensis* Mill., *Rhus glabra* L., *R. hirta* (L.) Sudw., *Azalea nudiflora* L., and *Clethra alnifolia* L. With a damper soil and generally more humus in the valleys and on the shaded hill slopes, the same shrubs as are found in the dry woods also occur, but in addition, we find as indicative of moister

soil: *Hamamelis virginiana* L., *Viburnum dentatum* L., *V. acerifolium* L., *Leucothoë racemosa* (L.) A. Gray, and *Celastrus scandens* L. In both types, the wet and the dry, the third layer also includes specimens of the dominant and secondary forest trees which have reached the level of the shrubs in their upward growth beneath the prevailing crown of the deciduous trees. This natural reproduction of the forest by the trees which form the facies indicates that the permanent and established succession of the natural highland woods is that which we have termed the chestnut-oak succession, or climax forest. If the natural conditions are preserved by the establishment of a state forest on these picturesque hills of the Navesink Highlands, there is every reason to believe that the climax forest will perpetuate itself.

The fourth layer consists of the low shrubs which fill up the ground space beneath the taller shrubs. The low shrubs of these dry woods are *Gaylussacia frondosa* (L.) T. & G., *G. resinosa*, *Vaccinium pennsylvanicum* Lam., *Comptonia peregrina* (L.) Coult., and *Myrica carolinensis* Mill. These are propagated largely by underground parts, so that they form extensive clumps (families of Clements) to the exclusion of all other plants. In the pine barrens of New Jersey these species also occur, except *Myrica carolinensis* which becomes there edaphically suited to the moist soil of cedar swamp margins. We are hardly in a position to say that these low shrubs have entered the dry deciduous woods from a pine barren source of supply, but they occur in the pine barrens and in the dry chestnut-oak woods, because they can thrive in a dry soil. Similarity of edaphic conditions here as elsewhere encourages the same kind of vegetation.

The herbaceous or fifth layer which sometimes replaces the fourth layer, as it is in turn by a close growth of the low shrubs prevents the growth of woodland herbs, consists of such species as *Pteridium aquilinum* (L.) Kuhn, *Aralia nudicaulis* L., *Melampyrum lineare* Lam., *Sericocarpus asteroides* (L.) B. S. P., *Vagnera racemosa* (L.) Morong, *Prunella vulgaris* L. (introduced), and *Anaphalis margaritacea* (L.) Benth & Hook. In midsummer the total lack of bright color due to summer flowers is noteworthy in describing the vegetation in general at that season of the year.

As a ground layer, or sixth layer, the forest of the Navesink Highlands has a forest floor consisting of litter and leaf mould, the brownish gray monotony of which is relieved by green cushions of *Polytrichum* sp., trailing mats of *Epigaea repens* L., and isolated plants of *Cypripedium acaule* Ait.

Vegetation on the Hill Slopes

The forest on the slopes of the Navesink Highlands (Fig. 3) comes down to a narrow sand-gravel beach, or it comes in contact with small areas of salt marsh.* The immediate shore line

Fig. 3. Wooded slope, Navesink Highlands, showing deciduous forest on north slopes and the shore-line protected by loose rocks.

of the beaches is characterized by salt water plants, but on the upper beach grows an association of species including *Baccharis halimifolia* L., *Rhus copallina* L., *Sambucus canadensis* L., *Solidago sempervirens* L., *Hibiscus moscheutos* L., *Xanthium canadense* Mill, *Convolvulus sepium* L., and *Eupatorium perfoliatum* L., which tend to mingle with trees of the bluff face, such as *Celtis occidentalis* L., *Juniperus virginiana* L., *Vitis Labrusca* L., and *Rhus radicans* L.

* *Harshberger, John W. l. c.*

Barren Plant Formation

On the level summit of the Navesink Highlands at a point overlooking Sandy Hook Bay occurs a plant formation which is entirely distinct from the surrounding deciduous tree formation previously described. The whole formation is an open one and has not reached a climax condition. Here the edaphic conditions control, because the trees which enter this formation are all more or less dwarfed with their lower branches close to the ground and separated from each other by wide intervals, so that the sunlight can reach the ground all around the base of the trees. The chestnut, *Castanea dentata* (Marsh) Borkh.; the red oak, *Quercus rubra* L.; the scarlet oak, *Q. coccinea* Wang; the aspen poplar, *Populus tremuloides* Michx.; the red maple, *Acer rubrum;* the pignut hickory, *Hicoria glabra* (Mill) Britt.; the cherry birch, *Betula lenta* L.; the wild cherry, *Prunus serotina* Ehrh.; the tulip poplar, *Liriodendron Tulipifera* L.; the red cedar, *Juniperus virginiana* L.; the chesnut oak, *Quercus prinus* L., and the pitch pine, *Pinus rigida* Mill, are components of this unusual formation. Each species is represented in general by a single specimen which is more or less dwarfed in habit, assuming a rounded form. Associated with these trees and growing in the dry soil, which is bare at intervals, are found such shrubs as *Myrica carolinensis* Mill, *Rhus glabra* L., *Comptonia peregrina* (L.) Coult., and the following herbaceous plants noted in their summer (August) aspect: *Hudsonia tomentosa* Nutt., *Panicum virgatum* L., *Chrysopsis falcata* (Pursh) Ell., *Eupatorium album* L., and *Sericocarpus asteroides* (L.) B. S. P. Such lianes as *Parthenocissus quinquefolia* (L.) Planch. and *Rhus radicans* L. occur in a straggling growth by taking avail of the dwarf trees previously described. The presence of this formation is probably to be explained by the existence of some undenuded remnant of an impervious overlying stratum, such as the indurated green earth which stratigraphically is above the characteristic red sand.

The forest covering of the Navesink Highlands is, therefore, one of great uniformity. Practically, although minor differences are noticeable owing to a difference of exposure and edaphic conditions, the chestnut-oak facies represents the climax succession.

Consequently in describing the facies there is put upon permanent record the conditions as they existed during the summers of 1908 and 1909 before the despoilation of this valuable tract of woodland made a phytogeographic survey impossible.

University of Pennsylvania

FLORAL PERFUMES*

By Margaret Tucker

"Floral Perfumes: The Land and the Laboratory" is the title of the chapter in R. K. Duncan's recent book "The Chemistry of Commerce" which deals with the commerce in perfumery.

In the production of perfumes, Professor Duncan tells us, three distinct industries are involved: First, the extraction from the plant of its odoriferous principles in pure and concentrated form; second, the artificial synthesis of these principles or their successful simulation; third, the utilization of these products in the art of manufacturing perfumes.

The center of the first industry, the extraction of the natural essences of the flowers, is at Grasse, a quaint little town in the south of France, where from May till November the people are busy gathering the flowers in their season: violets, jonquils, roses, orange-flowers, thyme, rosemary, myrtle, tuberoses, jasmine, aspic, lavender from the higher Alps, and red geranium. These approximate a total weight of from ten to twelve billion pounds annually, which means a quite inconceivable number of flowers — five billion jasmine flowers alone — all picked by hand.

There are four methods for the extraction of the perfume from these flowers: (1) Distillation by steam, which results in extracted oil, and a water distillate saturated with the valuable essence which in the case of many flowers is sold as "distilled waters" known as rose-water, jasmine-water, etc. (2) Cold *enfleurage*, used for the more delicate flowers: jasmine, tuberose, and jonquil. This is a process in which every day new flowers are laid on sheets of cold pure lard, until it becomes a saturated "pomade" of essence. The solution of perfume is then extracted by

* This review was written for the teachers' department, but it is so readable that, with this explanation, it has been placed in the main part of the magazine.